due to diffusion limitations. The cooling efficiency decreased as a function of distance away from the coolant injection point, which is probably due to the reduced coolant concentration.

98/01514 Thermodynamic investigations of desulfurization and emission of heavy metals in combustion
Meyer, B. *et al. DGMK Tagungsber.*, 1997, 9703 (Proceedings ICCS '97, Volume 2), 1059–1062.
Low sulfur content and low SO_2 emissions are characteristic of pulverized fuel from Lower Lusatian brown coal. Complex thermodynamic calculations were used to investigate the effects of the ash composition and the efficiency of the admixture of additional lime. Lusatian brown coals and their refining products are interesting for combustion together with sewage sludge and other waste materials, due to their extremely low contents of heavy metals and other trace elements. In the thermodynamic equilibrium, all heavy metals—except for Hg—are deposed during the cooling of the flue gas in the case of an optional combustion of 5% of sewage sludge in a pulverized-fuel combustion.

10 ENGINES

Power Generation and Propulsion, Electrical Vehicles

98/01515 An externally fired evaporative gas turbine cycle for small scale biomass gasification
De Ruyck, J. *et al. Biomass Energy Environ., Proc. Eur. Bioenergy Conf., 9th*, 1996, 1, 260–265. Edited by Chartier, P., Elsevier, Oxford, UK.
A demonstration project supported by the Thermie programme of the European Commission is presented. A CHP gas turbine plant fuelled by product gas from a biomass fluidized-bed gasifier has been constructed and commissioned. The fluidized-bed gasifier is designed for sawdust. The target commercial scale is 2–5 MWe and atmospheric gasification and external firing through a high temperature metallic air heater are proposed. Some natural gas topping combustion will be included in the gas turbine to overcome the temperature limitation of the metallic heater which is about 850°C. Water injection in the air heater is included to enhance power output and to allow flexible power to heat ratios. The demonstration scale is 500 kWe, for production of power and heat for the University campus district heating. The project aims at maximum performances of 70% total and 24% electrical efficiency. The target for water peak electrical efficiencies is approaching 30% and for output power it is up to 700 kWe.

98/01516 Improvement of domestic steam turbine units and merits of developing pilot power blocks operating on superhigh steam parameters
Trukhnii, A. D. *et al. Teploenergetika*, 1997, (1), 2–8. (In Russian)
Steam turbines at superhigh parameters of live steam are analysed regarding the design, construction, and operation. The boiling steam turbine and turbo-unit are suggested of pilot power block. The technical requirements for new generation, coal-dust fired power blocks are discussed.

98/01517 Method for operating a gasification reactor
Meurer, F.-J. Ger. Offen. DE 19,610,490 (Cl. C10J3/06), 25 Sep 1997, Appl. 19,610,490, 18 Mar 1996, 5 pp. (In German)
Gasification of solid combustibles for their use in a turbine is carried out and the fuel gases are fed into the turbine only after they have been cooled sufficiently to condense out the less volatile components. These components are collected and injected into the turbine using an atomizing nozzle. The components are preferably sprayed into the flame when the flame temperature is low.

98/01518 Mixture of triethylamine (TEA) and benzene as a new seeding material for the quantitative two-dimensional laser-induced exciplex fluorescence imaging of vapor and liquid fuel inside SI engines
Fröba, A. P. *et al. Combustion and Flame*, 1997, 112, (1/2), 199–209.
It has been proved that a mixture of triethylamine (TEA) and benzene in iso-octane is a suitable seeding material for the study of the gasoline fuel mixture and evaporation processes under engine-like conditions. Laser-induced fluorescence (LIF) of the exciplex-forming mixtures of TEA and benzene has been investigated using a KrF-excimer laser at 248 nm as an excitation source. The dopants have physical and chemical properties that match well with the model fuel iso-octane and show only low absorption at the excitation wavelength. These are important criteria for materials to be used as tracer substances for the study of evaporation and mixture formation processes in SI engines. The tracer system is described. This system permits a quantitative detection of vapour-phase concentrations and fuel/air-ratios under engine like conditions is possible. The fluorescence intensity was found to be directly proportional to the fuel/air-ratio and independent of pressure for pressures higher than 3 bar. The temperature dependence of the fluorescence intensity has been studied in a temperature range from 398 to 523 K. A systematic decrease of the fluorescence intensity has been detected with increasing temperature. However, this is still directly proportional to the fuel/air ratio. The paper presents an application of the newly developed tracer combination for the quantitative two-dimensional imaging of the fuel/air-ratios in the vapour-phase and the simultaneous, spectrally separated detection of the liquid phase inside an SI engine.

98/01519 Redesign of coke-oven gas turbines
Dvornik, V. V. *Koks Khim.*, 1995, (9), 34. (In Russian)
A redesign of turbines was necessary in order to reduce coke-oven gas output, as a result of decreasing coal supply to a coking plant.

98/01520 A second-law analysis of the 'hot blast stove/gas turbine' combination by applying the parameter 'usable exergy'
Bisio, G. *Energy Convers. Mgmt*, 1998, 39, (3/4), 217–227.
A coupled arrangement is examined in which turbine waste gas is used as the oxygen carrier for combustion of the fuel gas in hot blast stoves and preheaters of a blast furnace. The blast furnace gas and the turbine waste gas are preheated by the combustion of blast furnace gas, in order to achieve the necessary combustion temperatures. Using this arrangement it is also possible to make use of the external thermal energy. A comparison is made between the coupled process and a hot blast stove system and a gas turbine plant without waste thermal energy recovery, which operate separately. The concept of usable exergy, a previously defined parameter, is employed to compare the two configurations. Some of the results obtained by a first-law analysis are reversed.

98/01521 Small-scale AFBC hot air gas turbine power cycle
Ashworth, R. A. *et al. Proc. Int. Conf. Fluid. Bed Combust.*, 1995, 13, (2), 1145–1158.
A small scale atmospheric fluidized bed combustion (AFBC) system, developed by the Energy and Environmental Research Corporation (EER), the Ohio Agricultural Research and Development Center (OARDC), the Will–Burt Company (W-B) and the US Department of Energy (DOE), was subjected to pilot plant tests. This system can be used to generate electricity, and/or hot water, steam. Results are presented for NO_x, CO and SO_2 emissions using an Ohio and an Alaska coal and a dolomitic and a calcitic limestone. The small scale AFBC has no internal heat transfer surfaces in the fluidized bed. Combining the combustor with a hot air gas turbine (HAGT) for electrical power generation can give a relatively high overall system thermal efficiency. A novel method for waste heat recovery from the gas turbine can be used to achieve a gross heat rate of 13,500 Btu/kWhr (~25% efficiency) for a small 1.5 MW_e plant. A low technology industrial recuperation type gas turbine is used that operates with an inlet blade temperature of 1450°F and a compression ratio of 3.9:1. Power generation for remote rural communities can be achieved with this technology, to replace diesel generators, or it can be used for small industrial co-generation applications.

98/01522 Stirling engines for biomass: state-of-the-art with focus on results from Danish projects
Carlsen, H. *Biomass Energy Environ., Proc. Eur. Bioenergy Conf., 9th*, 1996, 1, 278–283. Edited by Chartier, P., Elsevier, Oxford, UK.
New activities for biomass within the development of Stirling engines has resulted from the increased interest in the utilization of biomass in small combined heat and power plants. Most of the projects concentrate on small plants in the range from 3–10 kW electrical power, but some European projects are focusing on engines with electrical power of 30–150 kW. Two Stirling engines are under development in Denmark for biomass utilization. The maximum electrical power of the two engines are 36 kW and 150 kW. The design of the engines has been adapted to the special demands of combustion of wood chips, resulting in larger engines than those compared to engines for gas or liquid fuel.

11 PROCESS HEATING, POWER AND INCINERATION

Energy Applications in Industry

98/01523 Blast-furnace smelting of iron ore using a layered charge with addition of polymer wastes
Arshanskij, M. I. *et al.* Russ. RU 2,074,895 (Cl. C21B5/00), 10 Mar 1997, Appl. 96,115,131, 13 Aug 1996. From *Izobreniya* 1997, (7), 187. (In Russian)